# Air Force Digital Technical Orders: Technologies and Applications for the Future

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*The views expressed in this paper are those of the authors and do not necessarily reflect the official policy or position of the Institute of Information Technology Applications, the Department of the Air Force, the Department of Defense, or the US Government.*

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# Acknowledgements

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## ABSTRACT

*This twelve-month research study was a small part of a larger Air Force study to fulfill Department of Defense directives to transition to a digital environment for acquisition programs by the end of 2002.[1] (Appendix A) The research study, which involved over 200 active and reserve jet engine aircraft maintenance troops at installations nationwide, was designed to support the Air Force strategy of "Global Technology Deployment" by providing and testing jet engine maintenance technical order manuals in digital form, and integrating the correct technology to utilize the digital application. In addition, it speaks to the cultural issues associated with incorporating a dramatic technological change.*

*Participants were sent the latest version of the F-16 interactive electronic technical manual (IETM) software to use for a few months prior to testing "ruggedized" hardware. They were also sent a research survey, which measured the utility of the combination of software and ruggedized hardware. Finally, depot/vendor sponsored training on the software and hardware was provided at various installations. The study demonstrated the feasibility, using "ruggedized" hardware and advanced software combinations and the potential of expanding the use of other technologies into other areas of military logistics. Initial recruitment of participants was facilitated by the Air Force-wide deployment of IETM software to all F-16 Jet Engine Propulsion Maintenance Shops. The research survey and interviews proved to be useful for data collection, which allowed jet engine maintenance troops to express views and opinions on issues relevant to the overall Air Force Project. Of those participants that completed the survey, 90% indicated they agreed or strongly agreed that this was an effective method of maintenance. The research concludes with recommendations for developing and conducting future logistics technology research for the military.*

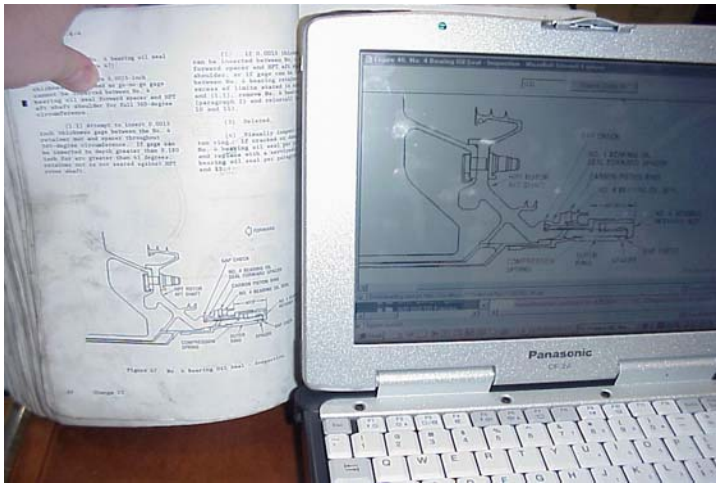
# AIR FORCE DIGITAL TECHNICAL ORDERS: TECHNOLOGIES AND APPLICATIONS FOR THE FUTURE

## INTRODUCTION

The Air Force Technical Order (TO) System provides educational and operational tools for supporting AF-wide operations and maintenance programs. The system acquires, maintains, stores, distributes, and manages technical information, instructions, and safety procedures pertaining to AF equipment. If TOs are not kept accurate and current, downtime for maintenance increases and operational readiness decreases. Untimely or inadequate technical information increases the possibility for damage or destruction of equipment and creates potentially unsafe operational and maintenance environments.[2]

The current TO system is primarily paper-based and was designed in the 1940s. Digitization of these documents began in FY97 with the B-1. Digitization extended to some munitions and weapons systems (AIM7-9, AGM-88, AGM-65, Aerial Targets, War Reserve Material (WRM) Ammunition, AEWS, GTACS, and Range Threats) in FY01. At present, digitization has been completed for the C-17, C-5, C-141, KC-10, C-130J, C-9, C-20B, CV-25.[3] In January, 2002, the first F-16 propulsion systems were fully digitized which allowed for improved interactivity through IETM's. The software was fielded to active and reserve Air Force installations to improve the efficiency and reliability of field maintenance on the aircraft. Current Air Force Logistics Plans are for IETM's to be utilized for all next generation aircraft and weapons systems which are currently under development.

Moving to a completely digital environment would be advantageous for several reasons. First, a digital environment would allow the most accurate and up-to-date TOs distributed electronically in the least amount of time. Secondly, there would be considerable man-hour savings in posting changes and errors would be virtually eliminated. Wear and tear on paper products would also be eliminated.




In addition, there would be a signification reduction of the "mobility footprint", when CDs or web-based access could replace paper during deployments. There are 1.4 million pages of technical data to support the F-16 fleet worldwide—about 14,000 pounds of paper.[4] One e-tool device, tested in this research, weighs about eight pounds and can hold the entire F-16 technical data set, saving valuable pallet space.

**Figure 1 Comparison of Paper vs Digital Technical Order**

## BACKGROUND

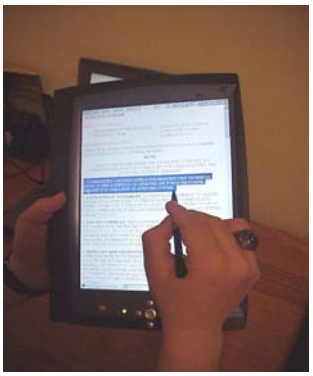


**Figure 2 goReader Device**

At the request of Air Force Reserve Command (AFRC)/LGA, Robins AFB, Georgia, the Institute for Information Technology Applications (IITA) was asked to perform initial testing of e-tools, using a particular "e-reader" device. The goReader (Figure 2) was selected to be tested simultaneously with an IITA classroom educational technology project. This device was tested at three F-16 bases, Buckley Air National Guard (ANG), Shaw AFB and McEntire ANG with disappointing results. Some of the major shortfalls were lack of memory and poor battery life. Most significant, however, was the lack of durability. When moving the reader device around, data would frequently surge or be completely lost. (See Appendix B, IITA Progress Report) Subsequently, IITA recommended follow-on research to be conducted on "ruggedized" electronic technology for digital TO use. AFRC purchased the Panasonic CF-28 Toughbooks for testing at 4 AFR F-16 Bases: The 944th Fighter Wing, Luke AFB, AZ; the 301st FW, Carswell JRB; the 419th FW, Hill AFB, Utah; and the 482nd FW, Homestead AFB, Florida. In addition, IITA purchased a Panasonic MDWD-07, "wearable" computer and Panasonic contributed one CF-34 Toughbook for additional testing.

## I. METHODS

*Experimental Design.* The objectives of this research were to examine the software and hardware associated with the Air Force digital Technical Order Program by providing the necessary IETMS software and hardware, facilitate training, and evaluate data use in the field. Subsequently, the methods used in this research included: Site Survey, Written Field Survey, and actual deployment evaluation of the digital Technical Order software and hardware.

*Agencies and Participants*. The research required selection of a sample populace of Jet Engine Maintenance troops to participate in testing the devices. Participants were selected with input from Air Force Reserve Command (AFRC), Air Force Materiel Command (AFMC), and the IETMS' project leads from the Air Force Depot Level Maintenance Program. Participants were both military and civilian, from both active and reserve forces and included all ranks within the logistics field.

The primary companies responsible for the development and programming of the IETM software included Air Force General Contractors Lockheed Martin and General Electric.

*Procedures.* In November 2001, the CF-28s were fielded to the 4 F-16 Reserve Bases. In January 2002, the bases received the latest F-16 engine IETMS.

### Site Survey

From January 2002 to May 2002 a series of site surveys were conducted to assist in implementing the new technology and administer surveys to gather data to determine the effectiveness of this technology. The principal criterion evaluated in the site survey included:

- The size of the display
- Ruggedization characteristics of the device
- Ease in locating the power button on the device
- The layout of the keyboard
- Ease in using the pointing device
- Navigating through the program
- Ease in entering data into the device
- The use of drop down menus
- Ease in reading data while the device was in direct sunlight
- The perceived portability of the device
- Ease in entering data while wearing chemical resistant gear
- Adaptation of the technicians to the new technology

**Figure 3 Technicians using the CF-34 and MDWD-07**

## Written Field Survey

A copy of the actual research survey used in the field is attached as Appendix B. The paper survey was designed to access whether or not the digital IETMS were actually utilized, determine the computer skill levels of the technicians and test the adequacy of the hardware used, primarily the Panasonic CF-28 Laptop. Data was obtained regarding the durability and ergonomic issues associated with the use of the laptop computer. In addition, assessments were made on the "comfort level" of the technicians with this technology.

## Deployment Evaluation

The actual deployment of the devices to off station locations was tested by both active and reserve bases. Deployment with IETMs digital Technical Orders was first attempted by Shaw Air Force Base in January 2002 during a training mission. However, due to the continuous upgrades taking place with the software and hardware, printed backup technical data was necessary to accomplish much of the maintenance during the

deployment to ensure continuity. In May 2002, the 482d Reserve wing, Homestead ARS, was able to successfully accomplish a small training deployment to Tyndall AFB without the need for paper TO assistance. The paper version was available for back-up.

## II. CONDUCTING THE RESEARCH

### Subject Demographics

The research data collected was from maintenance troops assigned to each of the bases listed in Table 1 below. Participants were required to attend training seminars on the use of the IETMS software and hardware. The total number of subjects participating varied due to both unit TDY schedules and individuals voluntarily requesting to be added or removed after the research survey period had begun. The decision to add personnel was based on whether or not the subject had received the Air Force IETMs training.

Wide varieties of expertise and years on the F-16 aircraft existed in the subject pool; therefore a typical profile could not be established. However, the following are significant facts on the participants which provide partial descriptions:

1. The average amount of Reserve experience working on jet engines was 11 years.
2. The number of subjects reporting ability to respond to the survey was 218.
3. Subjects were members of the active duty USAF, USAF Reserve, Air National Guard, and civilian Air Reserve Technicians.
4. While only 5 bases were actually visited, subjects applicable to this study were assigned to more than 15 different installations. This larger sampling was possible because IITA extended research by including all attendees at jet propulsion IETMs training, whose attendance was made up of technicians from active and reserve installations nation-wide.
5. Motivation to use the new technology varied, but was directly related to the level of computer skill expertise.

**Table 1: Site-Surveyed Bases**

| Date | Location | Number of Participants |
|---|---|---|
| Sep 01 | Shaw AFB | 55 |
| Feb 02 | Hill AFB | 83 |
| Mar 02 | Carswell ARS | 17 |
| May 02 | Homestead ARB | 51 |
| Jan 02 | Luke AFB | 12 |

### The IETM's Software

The software was developed by Lockheed and General Electric under contract with the Air Force Logistics Depot Maintenance Program. Each contractor has Defense agreements with the Department of the Air Force to develop the digital jet engine TO on the F-110 & 220 engines. Evaluation of the software took place prior to field deployment to determine the best possible hardware to be used with the program. The instructional design for each version of the digital TO consisted of a web-based menu on the left side

of each screen with the actual data appearing on the right side of the screen. Both remain visible on every page of the lesson. Data is largely available on CD-ROM in addition with web-server based capability.

Many recommendations were provided to the companies to improve previous versions. For example, the need for increased interactivity for maintenance user interface was demonstrated. The following table describes the components of the IETMS software.

**Table 2: IETM Software Translations/Definitions**

| MENU | Section Definition |
|---|---|
| TCTO | Time Compliance Technical Order |
| Work Package | WP- Portion of the TO that is being worked at a given time. |
| Diagram | Schematic technical drawings as used in printed paper TO's. |

The software was installed and resided on each hardware device tested. Limited CPU capability on the earliest ruggedized laptop models slowed the system. This was of particular concern with the flightline maintenance crews who needed timely information.

Subjects were provided "touch screen" capability and a stylus pen with each hardware device to immediately scroll or click to required TO data. Additionally, subjects required actual access to the unit Technical Order Distribution Office in order to assure the correct version of the CD-ROM was in use (over 15 different versions have already been produced).

Five days prior to each site visit, subjects were identified by the unit propulsion superintendent. This was to ensure that each subject had at least limited knowledge of using the application and computers. Additionally, during the site visit a demonstration period was conducted, followed by question and answer session before the research period began. Subjects then received 4 or more weeks to use the new hardware and software combination. The Depot made use of the technology mandatory for each installation undergoing the test, which helped facilitate greater participation in the project. Finally, technicians were administered the survey.

## III. SURVEY RESULTS

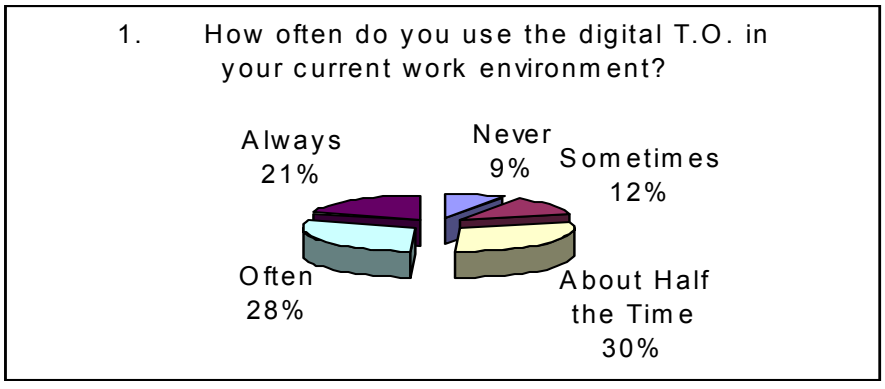



**Figure 4: Survey Responses**

Survey respondents indicated that usage of the digital TO's exceeded 20% at installations using IETM's software and hardware. An additional 28% indicated that they use the system often, but not all the time. A majority of respondents indicated use of the technologies at least half the time. Because the sample for this research was primarily composed of those trained and not completely familiar with the digital IETM's, field data may not accurately depict the actual usage of the technology for the entire force.

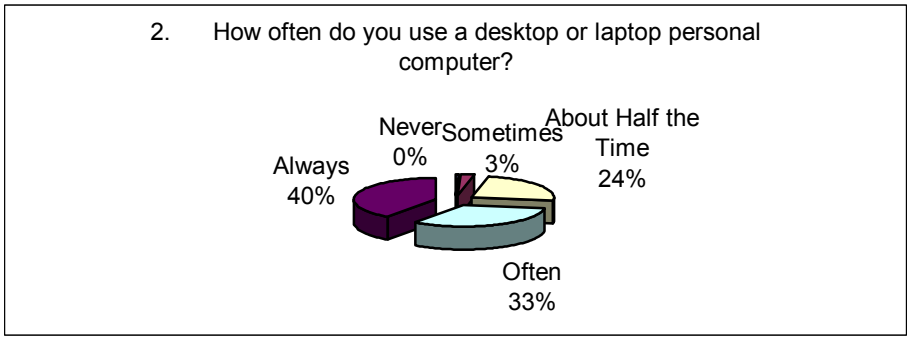



**Figure 5: Survey Responses**

Technology usage was a key element of this research because Air Force wide IT usage is generally lower in the operations and maintenance areas. In the propulsion engine shop arena, a majority of respondents indicated using computers of any type well over half the time. Much of this is a result of Air Force computerized aircraft maintenance system (CAMS) records as well as mobility aircraft data systems such as "GO81" and the command, control, communications, and information processing system (C3IPS). These systems, implemented over the past 10 years, now expose engine technicians to computers on a more frequent basis.

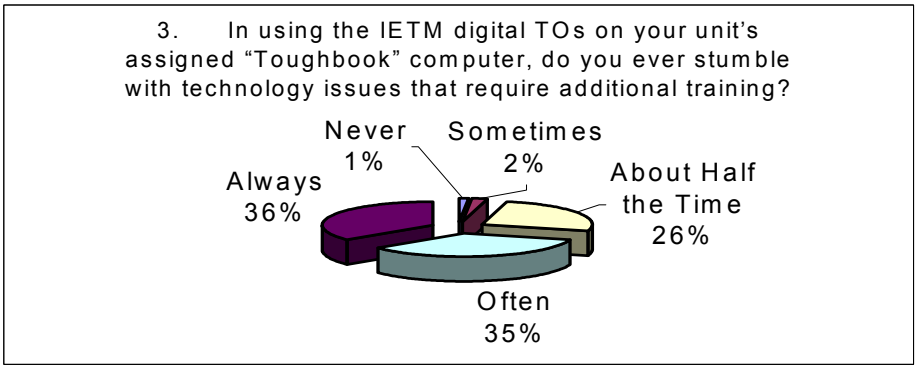



**Figure 6: Survey Responses**

A large number of survey respondents indicated that lack of training on usage of the IETM's product was an inhibitor to daily production. Due to cost constraints, training on IETM's was conducted for just 5% of installation troops. The training model calls for those fully trained to become subject matter experts (SME's) who, in turn, train the remaining troops in the unit. Results indicate that as of the survey period, the training was still necessary.

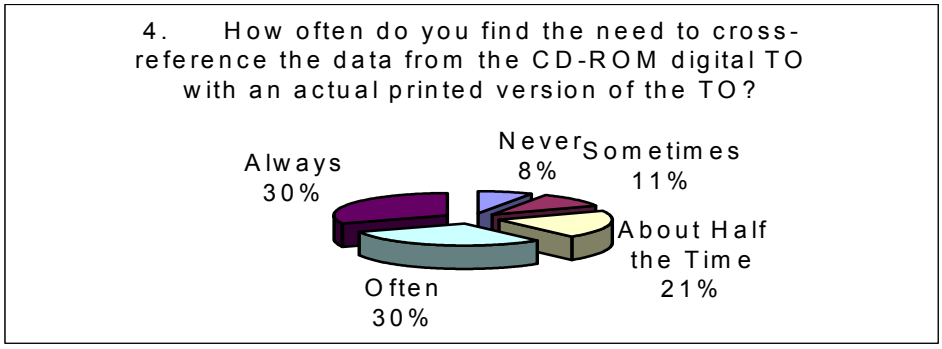



**Figure 7: Survey Responses**

60% of the maintenance troops who responded to the survey returned to paper TOs primarily due to the lower confidence levels on the accuracy of the IETMS technical order. Reliability was questioned as a result of the numerous revisions to the software. During the research period 7 versions of TO's and time compliance orders were made. This concern was forwarded by our research team to the Oklahoma City Air Logistics Center (OC-ALC) who is responsible for certifying and validating data on digital TO's for the F-16, Air Force wide. The Air Force TO Distribution office continues its effort in this area.

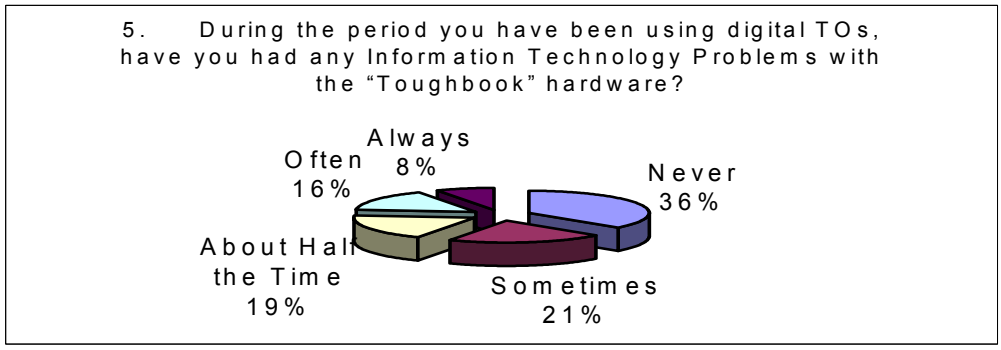



**Figure 8: Survey Responses**

IT troubles reported by respondents were higher than expected. Specific concerns were battery-life longevity, screen visibility, size of text, software, and connectivity. While many of these issues were alleviated with the acquisition of the CF-28, not all were abated. There were still concerns regarding the overall reliability of the electronic tools when becoming a 100% digital operation. In follow-up interviews with the test-bed location at Shaw AFB, SC, those workstations that were fully digital and utilizing IETMs software experienced very little or no difficulty when transitioning to 100% digital IETMS use. Comfort and training levels of the subjects were found to be a greater concern than the reliability of the data and electronic hardware.

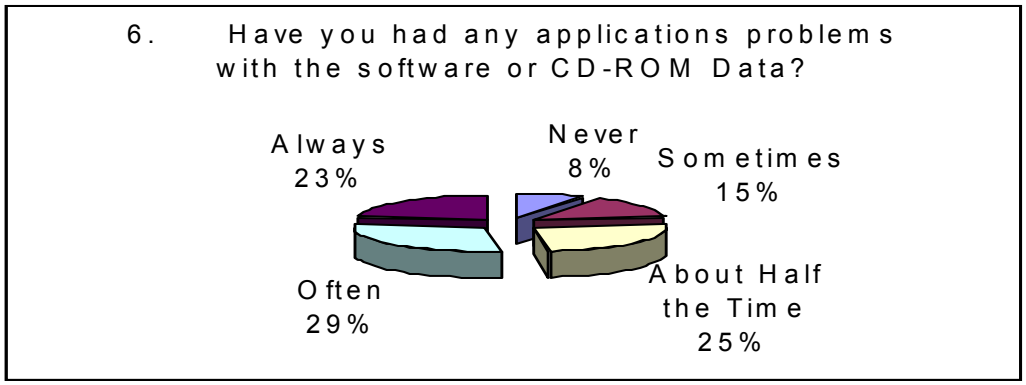



**Figure 9: Survey Responses**

Software applications problems did exist with IETMs and the Computer Automated Maintenance System (CAMS) platforms, especially when operating on the same hardware device. More than 50% indicated having some trouble with the IETMs applications of multiple web browsers, HTML Frames, and searching. For example, earlier hardware and software versions were slower while the processing speed on the CF-28 was much faster allowing for better use of web-based applications. Technicians who utilized both IETMs and CAMS on the same hardware device would like to see even greater speeds when opening graphic functions and searching for TO maintenance work packages. In addition, the IETMs application can present trouble by "locking-up" on slower PC's and hardware devices.

## IV. DISCUSSION

The data collected during this research points to the following major findings, categorized by Hardware, Software and Cultural issues.

### HardwareTechnology Issues

The primary hardware used was the Panasonic CF-28, but 3 other approved Panasonic systems, the CF-27, CF-34, and MDWD-07 were fielded to test hardware possibilities based on size, memory, portability, durability, and usefulness with the IETMs application. Hardware is listed in Appendix D. Scalability and durability were the key hardware technology issues tested. The goal was to reduce the size of computer needed to perform IETMs work, but still be adequate to display the TO. The hardware tested met scalability requirements.

Ruggedized durability features, which differentiate the product line from the typical PC or laptop device available to most consumers, were essential for flightline operations. Each hardware device tested was engineered for industrial use, and designed using Military MIL-STD-810E test procedures used by the Department of Defense. Features of the hardware included hardened polymer cases which could accommodate excessive weight pressure and prevent damage. A typical drop-test of the hardware involved an 8ft drop onto hardened concrete. Each device tested easily passed this test. In addition, the hardware was water, chemical, and moisture resistant. This characteristic was very important as Jet Engine Maintenance facilities are surrounded by fuels, oils, and grease. The typical device tested by technicians would get dirty and greasy within just a few days use. Webbed rubber lining for keyboards as well as gasket gated portals for the hardware helped maintain hardware integrity.

**Figure 10 Technician using MDWD-07**

The screens on the hardware were upgraded during this research to include touch screen capability and scratch resistant enhancements. This was important as technicians preferred to use their hands or even work tools as opposed to a computer stylus when scrolling through work documentation. These upgrades, coupled with on screen capability and visibility were helpful in allowing design engineers to accommodate military needs in advancing tools from the CF-27 to the CF-28 device. The most recent modification included reducing the screen power usage requirements to facilitate longer battery life for the associated hardware.

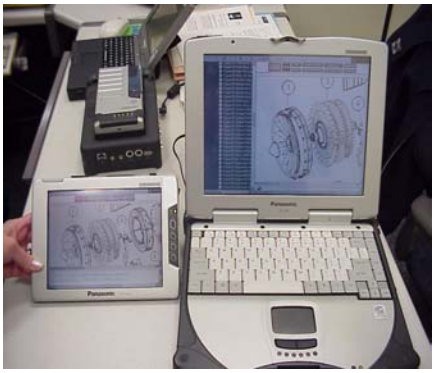


**Figure 11. Screen Comparisons**

## Software Issues

Software issues drastically improved throughout the research study as newer versions hit the field.

The early versions of digital TO's were not web-based. A text only version with PDF files were used which did not allow for viewing diagrams and graphs that are essential to engine maintenance work.

Software development involved moving all engine technical data to an interactive electronic format. Teams from AFMC and civilian software developers met to discuss the application, and in the end a web-based interface was selected as the most viable method due to troop familiarity with application such as Microsoft Internet Explorer.

Versions 1.0 and 2.0 of the IETM's software presented difficulty with data accuracy, processing speeds, and program execution due to the use of 'transposed' TO data which was converted form actual printed text and programmed in xTML and HTML web-based languages. This resulted in several delays, first in working out programming errors, and later in making the electronic data as accurate as the printed TO version. This process required data to be screened by Air Force TO managers.

At the same time, diagrams and other graphics were not drawn to scale when used in the web-based mode. As a result, the team decided to create an enhanced graphics interface which would allow for scalability of all images allowing them to be blown up beyond that of the traditional paper TO. As a result, one of the finer aspects of the IETMs software as discussed by troops was the ability to use enhanced images and graphics.

Later versions of the software addressed many shortcomings reported from the field. Today's IETM's allows for both network and non-network connectivity for data, and permits multiple windows to be opened at the same time allowing for troops to access both the TO, Indices, and other electronic maintenance applications on the same computer.

**Cultural Issues**

Preliminary assessment of troop "comfort" with the technology found some initial hesitation with implementation. In some cases, the site survey found researchers actually having to remove the equipment from original packing. After familiarization, the IETMS software, specifically the web-based format was found to be user-friendly and the subjects appreciated having everything they needed to do their work, but there were several 'fears of technology' which inhibited some troops from being solid survey subjects. For example, senior technicians were less computer savvy, while younger technicians navigated through the software fairly easy.

Virtually all subjects reported using the IETMS work packages for their maintenance tasks, both for routine maintenance and troubleshooting. Initially, senior troops would locate a work package digitally, and then migrate to paper based copies. However, younger troops, spent time learning each subsequent version of IETMs software, and demonstrated how the software could be used exclusively for engine maintenance work. Senior participants did not adapt well to multiple software version upgrades throughout the research period. These updates, though required by AFMC, made training on use of IETMS software more difficult.

With continuous use of the software application, several troops became more adept at using the digital IETMs application and found that using the computer search function was more efficient than paper based methods. This efficiency also stems from eliminating multiple trips to the TO library for additional data.

Due to the limited time period of this research, combined with Air Forces' 3-5 year plan for total force rollout of digital TO's, lower motivational levels were reported over the test period. However, the enthusiastic response to the future uses of the technology was received well. All subjects agree that programs of this type are a necessity and will be highly successful over the long-term. Virtually all participants found that TO information, diagrams, and data delivered in this manner would help them maintain their training and skill levels in performance of jet engine maintenance tasks. The bottom line:

1. Although most technicians were comfortable with the technology and most use the computer on a daily basis, about 20-25% used the digital TO for maintenance work. Research on digital TO use employed by aircraft jet engine mechanics indicates that the strategy most often employed by the troops was frequent return to the paper TO for reference – using the digital version first.

2. Technicians were very concerned about training on using IETM's and expressed a desire for further opportunities to better learn the computer applications and systems.

3. Each successive version of the software presented some confusion at the unit level as engine supervisors became increasingly concerned regarding the accuracy of digital TO data and the manner in which it might affect operational safety.

4. The age of the respondent was a significant determinant as to whether the user felt comfortable with the electronic applications.

5. Hardware upgrade of the CF-27 to CF-28 made a tremendous impact. Future upgrades to smaller machines such as the CF-34, or wearable MDWD-07 may present more operational efficiency.

6. A wireless use IETMs maintenance system is definitely needed to better connect back shop IETMs with the actual flightline

**Figure 12 CF-34 and Paper TO**

Besides improved deployment during expeditionary operations, current factors favoring digital software and electronic hardware based Technical Orders are the increasing technical complexity of military jet engines. As propulsion systems become more technologically advanced, reliable electronic tools are becoming more and more necessary in troubleshooting, repairing, and maintaining them.

Another favorable aspect of digital TO systems are the realized savings in materials and training costs from less reliance on printed materials, and improved economies of scale

associated with training dollars previously spent to upgrade the technical skills and experience levels of technicians.

Less favorable to TO digitization is the issue of Logistical control over maintenance assets and the potential of having advanced engines subject to technical repair orders that require immediate attention. Under the current maintenance structure, there is value to having technicians who know where to immediately find the TO data for a particular repair under given constraints for maintenance turn times.

Without question, the favorable results of this research outweigh the less favorable aspects, and there is solid validation in the survey data to support the Air Force Logistics community's move toward more digital products for maintenance and operations use.

## V. CONCLUSIONS/RECOMMENDATION

Deploying the Digital TO IETMs for the logistics community is feasible and viable. Several of the hardware devices tested worked, but the most recent laptop hardware, the Panasonic CF-28, proves to be the most efficient computer of choice for the digitization program. This was recommended to MAJCOM program managers and acquisition is moving forward at the present time.

It is recommended that the Air Force and others in the defense community develop enhanced over-the-counter technologies with durable capabilities that also increase user interface for software and hardware. This continuing research is allowing review of test and evaluation stages on a wide array of 'next-generation' handhelds, and alternative 'ruggedized' devices still in development. There is great value in continuing research in this area. Immediately on the horizon are:

- "Wearable" computers. These devices, tested in this research only on the MDWD-07, are not ready for Air Force wide deployment. There are still too many technology issues that inhibit the successful deployment of the technologies for military use such as peer to peer protocols that have limited range and require actual line of sight for the computer central processing unit (CPU) and wearable screen to function. This requirement does not operate well in the aircraft maintenance and logistics environment due to the number of components and equipment that often exist between technicians and their respective workstation location. In addition, it is recommended that larger, but still portable, display screens be added to Research and Development of the wearable computer products in order to better accommodate the ergonomic needs of both shop and flightline maintenance. Future testing will involve further integration of the wearable peer to peer improvements along with PCMA wireless technology in order to introduce a viable 'next generation' system.
- 
- "Wireless Data" Sample wireless data streams and the applicability to Air Force maintenance use in conjunction with the technologies tested for this research was briefly initiated. There is significant research potential for integrating the hardware from this research with the wireless maintenance environment.

- "Applying the Web." Web-based interfaces carry tremendous potential for military use. Applications that are web compatible are more user friendly and many troops already recognize the functions of the web interface from both their personal and professional PC use. Further movement into digitization of tech manuals and other military applications should include next generation web technologies and programming such as pop-ups, animations, better touch screen synergies, and synonymous display concepts.

In summary, it would be beneficial to:

1. Continue advancing use of this digital software/hardware capability
2. Transition to server and web-based TOs for instantaneous updates
3. Pursue wireless concepts to flightline/backshops
4. Incorporate tiger-team training
5. Apply interactive concept to other LG databases, i.e., supply system
6. Continue to follow technology with upgrades to portable solutions
7. Continue interactive transition to other weapon systems.
8. Evaluate hardware developed by other companies such as Dolch, Hewlett Packard and Dell which may facilitate next generation upgrade

An important next step in this research is to work with MAJCOMs and other services to advance digitization of technical data to various other weapons systems. The efficiency, cost savings, and real time capability of the digital applications is such that defense-wide research and development in this area are essential. Current technologies of both hardware and software will benefit from further expansion and newer versions that employ newer technologies. Each weapons system that enters the digital era will have fully upgradeable and timely changeable technical data which will benefit operations and maintenance as well as better facilitates modifications to any weapons system.

Elements of this research focused primarily on backshop maintenance. Another important step is to integrate flightline and backshop maintenance communications systems which will not only encompass digital TOs, but incorporate aircraft status tracking, flightline parts requisition, and back shop communications. This multi-faceted logistics management system will feed maintenance operations centers (MOCs) with accurate time-critical information on mission capabilities.

A concurrent formalized training program on IT applications associated with digitization is recommended. Updated skill level requirements on IT development tools and computer automated training devices and programs will be an essential part of preparing the force for next generation technologies to be used in the field.

Another concurrent effort should be in the monitoring of next generation hardware and software. Continued researched in to multiple displays with single server access, as well as ergonomic and technological improvements is essential in improving the digitization process. Web enablement, multi-functions tools, portability, and durability, are but a few of the additional issues that will be addressed in continuing research for digitization of defense weapons systems.

Appendix A

THE DEPUTY SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-1000

JUL 2 1997

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN, JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
DIRECTOR, DEFENSE RESEARCH AND ENGINEERING
ASSISTANT SECRETARIES OF DEFENSE
DIRECTOR, OPERATIONAL TEST AND EVALUATION
DIRECTORS, DEFENSE AGENCIES

SUBJECT: Policy for the Transition to a Digital Environment for Acquisition Programs

The Department has made substantial progress in the acquisition, management, and use of digitized information. It is now time to move forward to a fully digital environment in all acquisition program and support offices. Industry has already demonstrated that this is not only possible, but preferable to traditional paper-driven systems. I am setting a corporate goal of digital operations being the method of choice for all acquisition management and life cycle support information. By the end of 2002, the overwhelming majority of DoD acquisition and logistics operations should be based on digital methodologies and products.

The focus of this effort must be at the program office level. Consistent with the architecture established by the joint DoD level executive steering group, Program Managers shall be responsible for establishing a data management system and appropriate digital environment that allows every activity involved with the program throughout its total life-cycle to exchange data digitally.

I am counting on your support for this critical initiative that will enhance acquisition reform, further empower our Integrated Product Teams, and combine with electronic commerce to achieve greater efficiencies in the weapon system life cycle.

Appendix B GoReader Report

# IITA Progress Report

## Electronic Textbooks
## for
## Digital Technical Orders
## Phase I: goReader

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October 2001

## INTRODUCTION

Air Force Materiel Command (AFMC) Digital Technical Order (TO) Architecture and Transition status is progressing Air Force wide. This report contains data collected from testing the applicability of using a particular "e-reader" device for digital technical orders and assorted logistics applications in a field environment. The ability of electronic books (e-books), palm reader (e-reader), or industrial PC laptop users to apply the digital TO data to daily maintenance or other logistical operations enhances mission performance. Ease of deployment, interactivity with publication data, highlighting, updates, adjusting size and resolution, and luminosity of the display are some other major advantages.

## BACKGROUND

Technical Order warehouses take up roughly 250,000 sq ft of valuable floor space and cost $12M/year to operate. A typical flying squadron dedicates a 12x16 ft room to the TO library and spends 90 to 120 man hours per month maintaining it. MC-130H aircraft carry a TO library that weighs 270 lbs. Airline studies show approximately 20% reduction in turn time on aircraft maintenance. (AFMC/DRR brief, 13 Aug 01)
The majority of the AF TOs have already begun digitization. Currently all major Air Force Commands are working through AFMC to ensure timely transition to useful technical orders for active and reserve maintenance personnel. The concept of the Interactive Electronic Technical Manual (IETM) was developed in the mid 1990's, and is, at present, coordinated jointly with USAF Propulsion contractors Pratt and Whitney, and General Electric.

## RESEARCH OBJECTIVE

Determine if electronic books are a suitable document format for equipment manuals? Can they support weapon system schematics? Could this be an improved solution for updates? Can these devices simplify deployments?

## PROJECT DESCRIPTION/METHODOLOGY

Initially, testing began by seeking digitization status of Technical Orders, and other Air Force Manuals and Publications. Working with HQ AFRC/LGA, Robins AFB, Georgia, it was determined that the best weapons system program office to gauge progress on data digitization for use on an "e-reader" device was the fighter engine management office located at Wright Patterson AFB, Ohio. The F110-GE-129 engine, used extensively by active duty and reserve units on the F-15 and F-16 weapons systems, currently has comprehensive digital data that is applicable to testing on "e-readers." IITA obtained a copy of the IETM digital TO on CD ROM and tested the data and its use on the goReader device with the following maintenance units:

1. F-16 Logistics Group at Buckley ANGB
2. F-16 Logistics Group at Shaw AFB SC
3. F-16 Logistics Group at McEntire ANGB, SC

A survey was conducted with the maintainers in each unit to address project objectives.

## RESULTS

**Buckley AFB, ANG F-16 Unit**: In this test, researchers presented the goReader device and TO data in non-vector format for discussion and review by maintenance troops. Many of the enlisted engine troops were thoroughly impressed by the size and screen resolution of the goReader. Questions regarding the durability of the device were brought up often, and data was loaded and used interactively in a non-shop environment. The unit is not currently aligned for digital TO use, so feedback was taken, but operational testing was limited.

**Shaw AFB, F-16 Unit**: The 28th Wing is currently the "test base" for USAF digital TO deployment. The Component Repair Squadron Propulsion Shop is the most fully capable at computer applications, testing, and actually using digital TO's on reader devices. The goReader device was loaded with as much TO data as possible. One weakness, determined in the field, was that the memory capacity of the goReader was insufficient for the entire digital engine TO. Maintenance troops liked the screen size and resolution of the data, but durability was a major problem. In moving the reader around, often times the data would surge or be lost. In addition, the concept of using a reader with a larger data memory bank or even CD ROM Reader was brought up.

**McEntire ANG.**
Currently, this is the only Guard Wing to utilize IETMs on shop engine maintenance. The technician we interviewed at McEntire ANG was thoroughly impressed by the technology and upgrades continually being made to the technology. PC Reader was the preferred mode of reading data; however, in ebook form, the data was useful as long as no scrolling or data searches were required. The technician preferred not to move the reader, and instead, consulted it when data or schematic information was necessary.

## CONCLUSION

**Objectives:**

Determine if electronic books are a suitable document format for equipment manuals?

**IITA research has found that there are suitable software applications for the electronic books with regards to digital data used by the Air Force. Field Manuals, Maintenance Technical Orders, Supply/Logistics inventories, and an array of other applications are highly feasible with reader devices and durable PC e-book technology.**

Can they support weapon system schematics?

**Data on Maintenance Schematics were originally scanned and programmed in raster or "image only" format, which is highly viewable on e-reader technology. However, AFMC, along with several defense contractors are working to make the schematics more navigable for our technicians and troops by converting to vector or "scale adjustable images" which are only readable on e-readers with CPU capability (i.e. PC notebooks, or their hybrid technologies).**

Could this be an improved solution for updates?

**Expanding the memory capability and enhancing the durability protection of the e-reader or GoReader would provide one alternative. Also, the ability to read a CD ROM either with the e-reader or a nearby docking station would be helpful in order to make entire digital libraries of data available to the technician with ease of access and convenience of usage.**

Can these devices simplify deployments?

**Yes, without question, the use of e-reader devices and compatible PC reader technology makes deployments easier. There are not as many data library items required for deployment, and the data is more conveniently accessible. We are seeing the use of interactive e-readers and durable notebook technology used more and more in the field.**

## SURVEY

### Survey Questions
### *(goReader and AF Digital Technical Orders)*

1. Could the goReader device accept the sample digital TOs?

   Yes, the goReader device could accept digital TO's. However, the successful use of the TO currently requires either a CD Rom reader capability, or extensive memory beyond the 15MB currently available on the goReader.

2. Was it readable?

   Data was readable in PDF Format Only. Other Raster and Vector versions of the digital TO's are not readable on the existing goReader software.

3. How much data could be loaded? (How many volumes of TOs could the device load?)

   Currently the goReader could maintain up to 15 MB of TO's, however, the data must all be stored on goReader data cartridge to prevent loss. A typical TO CD consists of up to 640MB of data, and requires Internet access at times to access changes and new TO data.

4. Could the data be manipulated in any way? (Highlighted? Note-taking? Printing?)

   The goReader allowed for Highlighting, and Note-taking using on-screen displays. Printing was very difficult without a print driver or compatible PC to mate with the goReader. When data files were shared successfully between the goReader and the PC's, the data was fully usable, which is a leading result for recommending the use of actual PC or laptop technology made durable for industrial or field use.

5. How much battery-life?

   Very poor…not more than 2 hours extended life in any of the trials.

6. Is it durable enough for flight line use and deployments?

   The device is not very reliable… While we did not expose the device to any condition which might break it, we did shake and move the goReader around. Many times resulting in complete loss of data and requiring re-boot. Durability would have to be improved before flight line use could be recommended.

7. What is the process for updates?

   Currently, TO updates are made on the Internet by the TO Distribution Officer (TODO) headquartered at Oklahoma City Air Logistics Center. The goReader requires either mating or a direct Ethernet connection to get the Internet updates, and then needs to be mated to a PC or laptop in order to use the full CD data in accessing the file downloads.

8. What enhancements would you like to see?

   Hybridization in product types between the goReader and a typical PC would be quite useful. Reliability, with processing and data storage power, as well as durability is the key tenets of making a successful device that can be used by the military. Troops likes the large screen display and touch capability of the goReader, but data retention and access to the full complement of Internet and CD based data were a major shortcoming. In addition, we cannot say enough about the lack of durability of the product.

## PHASE II PLAN

Research found that digital TO readers would be more successful with durable technology associated with the reader such as the Panasonic “Toughbook,” or Dolch Computer Systems technology. These added secure data features reduce the loss of data in the industrial or field environment providing reliability greater than 95% for data storage, digital display, and portability. As goReader technology evolves, IITA believes there will be expanded potential usage for Dolch hard casing in order to preserve data as well.

A proposal will be submitted to research “ruggedized” electronic technology on digital TO use. IITA is seeking partnership with AFRC/LGA**.**

## Appendix C Survey


**DIGITAL TECHNICAL ORDERS (T.0.) EVALUATION DATA**
**USER FEEDBACK**

BASE: _____ DATE:_____

NAME/RANK: _____ EVALUATION PERIOD:_____

**Introduction: The Panasonic CF 28 Laptop computers are part of a larger program being evaluated for the Air Force. Your comments and opinions are of extreme value, thus, we thank you for your participation. Please feel free to express your opinion about the computers and whether or not you think it is a viable replacement for paper-based technical orders. The results of this survey will be available in a technical report at the conclusion of this project.**

**PART I**
Please circle your responses to the following questions:

1. How often do you use the digital TO in your current work environment?

| Never | Sometimes | About Half the Time | Often | Always |
|---|---|---|---|---|

2. How often do you use a desktop or laptop personal computer?

| Never | Sometimes | About Half the Time | Often | Always |
|---|---|---|---|---|

3. In using the IETM digital TOs on your unit's assigned "Toughbook" computer, do you ever stumble with technology issues that require additional training?

| Never | Sometimes | About Half the Time | Often | Always |
|---|---|---|---|---|

Please describe the problems you have encountered and provide specific examples. (Use the back of this survey if you need more space.)

_____

_____

4. How often to you find the need to cross-reference the data from the CD-ROM digital TO with an actual printed version of the TO?

| Never | Sometimes | About Half the Time | Often | Always |
|---|---|---|---|---|

5. During the period you have been using digital TO's, have you had any Information Technology Problems with the "Toughbook" hardware?

| Never | Sometimes | About Half the Time | Often | Always |
|---|---|---|---|---|
| | | | | |

Please describe the problems you have encountered and provide specific examples.

_____

_____

_____

6. Have you had any applications problems with the software or CD-ROM Data?

| Never | Sometimes | About Half the Time | Often | Always |
|---|---|---|---|---|
| | | | | |

Please describe the problems you have encountered and provide specific examples.

_____

_____

_____

**PART II.**
Please circle the best rating for each of the following items and provide comments as necessary:

1. **QUALITY**
   - **a.** ***Ease of Use*** Poor Fair Good Excellent

     Comments _____
   - **b.** ***Picture Quality*** Poor Fair Good Excellent

     Comments _____
   - **c.** ***Readability*** Poor Fair Good Excellent

     Comments _____
   - **d.** ***Font Quality*** Poor Fair Good Excellent

     Comments _____

   - ***d. Features (finding, indexing, note taking, linking)***
     Poor Fair Good Excellent

     Comments _____

   - **e.** ***Battery Life*** Poor Fair Good Excellent
     What was the actual battery life?_____

**2. PRACTICALITY**

**a.** ***Time-Savings*** Poor Fair Good Excellent

Comments _____

**b.** ***Rate vs. Paper TO*** Poor Fair Good Excellent

Comments _____

**c.** ***Portability*** Poor Fair Good Excellent

Comments _____

**d.** ***Reliability*** Poor Fair Good Excellent

Comments _____

**e.** ***Durable*** Poor Fair Good Excellent

Comments _____

**PART III. WRITTEN RESPONSES**

**1. On average, how many hours per day did you use the Laptop?**

**2. Which TO data files did you utilize?**

_____

**3. What was the best thing(s) about the Laptop?**

_____

_____

_____

**4. What feature(s) would you add? Delete?**

_____

_____

**5. Please give us your overall opinion of the CF 28 Laptop.**

_____

_____

**6. Other comments:**

_____

_____

_____

_____

# APPENDIX D

## Equipment Description

Equipment tested was acquired through either the Air Force Reserve or vendor test-loan programs.

### Panasonic CF-27


### Panasonic CF-28

**Panasonic CF-34**


**Panasonic MDWD-07**

## GLOSSARY OF DIGITAL TO JET ENGINE MAINTENANCE STANDARDS, DEFINITIONS AND TERMINOLOGY

| | |
|---|---|
| AFMC | Air Force Material Command |
| ANG | Air National Guard |
| AFR | Air Force Reserve |
| AFRC | Air Force Reserve Command |
| ARS | Air Reserve Station |
| CAMS | Core Automated Maintenance System |
| C3IPS | Command, Control and Communications Information Processing System |
| CPU | Central Processing Unit |
| DoD | Department of Defense |
| FMC | Fully mission capable |
| FW | Fighter Wing |
| GO81 | Tanker/Cargo aircraft version of CAMS |
| HTML | Hyper Text Markup Language |
| IETM | Interactive Engine Technical Manual |
| IITA | Institute for Information Technology Applications |
| MC | Mission capable rate |
| NMCM | Not MC for maintenance, unscheduled or scheduled rate |
| NMCS | Not MC for supply rate |
| NMCB | Not MC for maintenance and supply, unscheduled or scheduled rate |
| TNMCM | Total not MC for maintenance (NMCM + NMCB) rate |
| TNMCS | Total not MC for supply (NMCS + NMCB) rate |
| OC-ALC | Oklahoma City-Air Logistics Center |
| PCMA | Power Controlled Multiple Access |
| PDF | Portable Document Format |
| PMC | Partially mission capable |
| PMCM | PMC for maintenance rate |
| PMCB | Partially MC both maintenance and supply rate |
| PMCS | PMC for supply rate |
| TO | Technical Order |
| SME | Subject Matter Expert |
| xTML | Extensive Telephony Markup Language |

## Glossary of Air Force Technical Orders

| | |
|---|---|
| 00-5-1 | Air Force Technical Order System |
| 00-20-1 | Aerospace Equipment Maintenance General Policy and Procedures (with RAC 1 incorporated) |
| 00-20-2 | Maintenance Data Documentation |
| 00-20-5 | Aerospace Vehicle Inspection and Documentation |
| 00-25-107 | Maintenance Assistance |
| 00-25-254-1 | Comprehensive Engine Management System Engine Configuration, Status, and TCTO Reporting Procedures |
| 00-35D-54 | USAF Deficiency Reporting and Investigating System |

## End Notes

[1] Deputy Secretary of Defense Memorandum, "Policy for the Transition to a Digital Environment for Acquisition Programs, 2 July 1997

[2] Air Force Technical Order Transformation, *Architecture/Transition Roadmap*, Directorate of Requirements, HQ Air Force Materiel Command, August 2002.

[3] Colonel Thomas Di Nino, HQ AFMC/DRR, PowerPoint briefing on *Air Force Technical Order Vision briefing on Architecture/Transition Status*, slide 47 and 48, 13 Aug 2001.

[4] Air Force News, "Air Force Going Digital with Technical Orders", by Senior Airman Lee Watts, 20th Fighter Wing Public Affairs, Shaw AFB, SC (AFPN)